# Waiting Online versus In-Person in Outpatient Clinics: An Empirical Study on Visit Incompletion

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## Background and Goal

Develop evidence-based approaches for the management and integration of telemedicine and in-person visits. Take an empirical approach to understand differences between patient's behavior online and in-person, and its implication to **intraday sequencing** decisions.

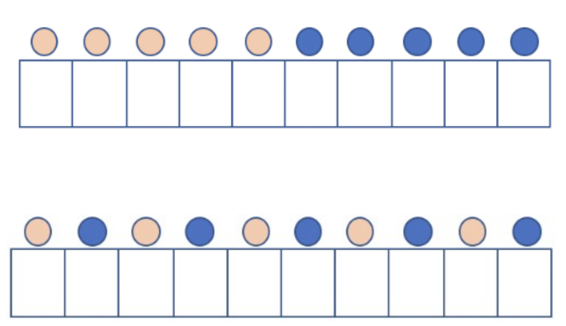

Figure 1. Intraday sequencing: block (top) vs. alternating (bottom)

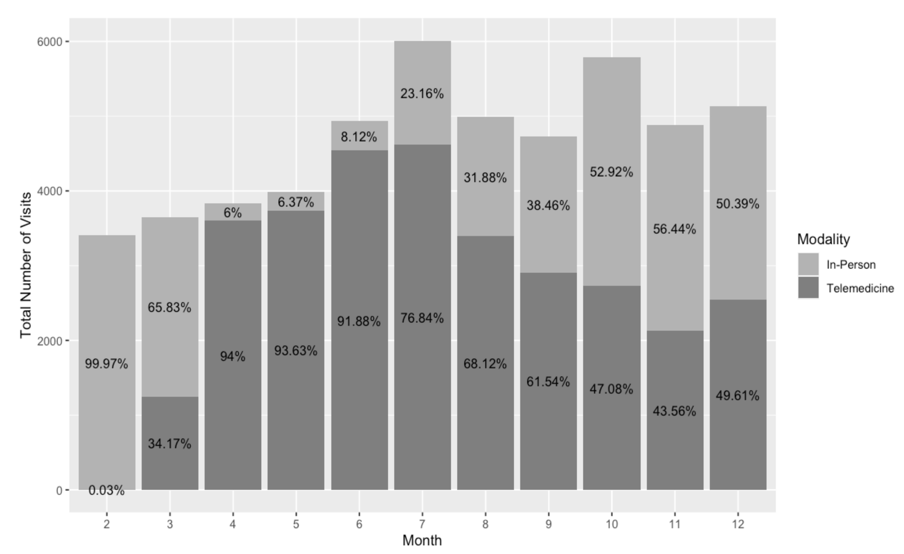


Figure 2. Total number of visits of our collaborating medicine clinics in each month of 2020, stratified by modalities.

## Empirical Setting

Appointment data from two largest outpatient clinics of medicine department at CUIMC from Feb to Dec 2020. Average incomplete rate is 20% for both in-person and telemedicine patients.

## Research Questions and Main Findings

**Q:** What is the impact of physician availability on visit incompletion?

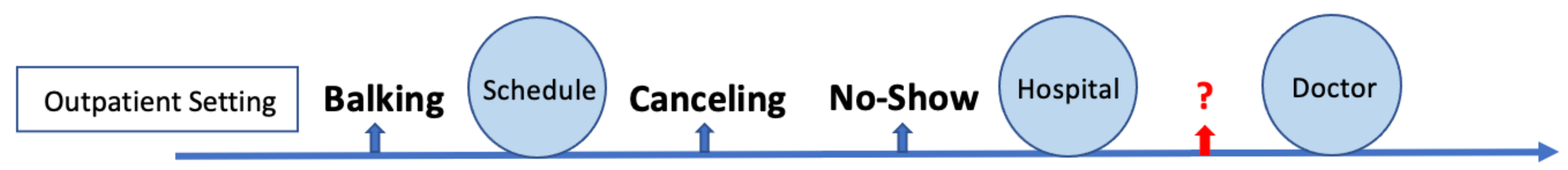


Figure 3. Patient visit process in the outpatient setting. An incomplete visit can be caused by no-show or abandonment.

**A:** If the doctor is ***available*** at the scheduled start time, telemedicine visit incomplete rate decreases by **7.4%** while in-person visit incomplete rate does not change significantly. This can be translated into the abandonment rate of telemedicine patients being **9%** and that of in-person patients being **0**.

## Estimation Strategy

### Challenges: endogeneity, measurement error, and missing values

### Main model: multivariate probit

$$\begin{aligned} Incomplete_i &= 1\{\beta_1^T X_{1i} + \delta Available_i + u_{1i} > 0\} \\ Available_i &= 1\{\beta_2^T X_{2i} + \alpha_2 PreWorkProv_i + u_{2i} > 0\} \\ ReportTrue_i &= 1\{\beta_3^T X_{3i} + \alpha_3 RelWorkClinic_i + u_{3i} > 0\} \\ Observe_i &= 1\{\beta_4^T X_{4i} + \alpha_4 WorkClinic_i + u_{4i} > 0\} \end{aligned}$$

Observed data

$$z_i = \begin{cases} (X_i, Incomplete_i, Available_i \times ReportTrue_i), & \text{if } Observe_i = 1 \\ (X_i, Incomplete_i), & \text{if } Observe_i = 0 \end{cases}$$

$$X_i = (X_{1i}, X_{2i}, X_{3i}, X_{4i}, PreWorkProv_i, RelWorkClinic_i, WorkClinic_i)$$

- ***PreWorkProvider*** is # of **scheduled** appointments within a 3-hour window **prior to** the focal visit of the **same provider**. This IV deals with endogeneity of availability.
- ***ReportTrue*** indicates whether ***Available*** is correctly reported by the medical staff. The partial observability model deals with measurement error (Nguimkeu et al. 2019).
- ***Observe*** indicates whether ***Available*** is missing. The Heckman selection model deals with (potentially non-random) missing value bias (Wooldridge 2010).
- The error terms follow a multivariate normal with pairwise correlation. The full model can be estimated via Full Maximum Likelihood Estimation (FMLE) (Cameron and Trivedi 1998, Wooldridge 2010).

## Counterfactual

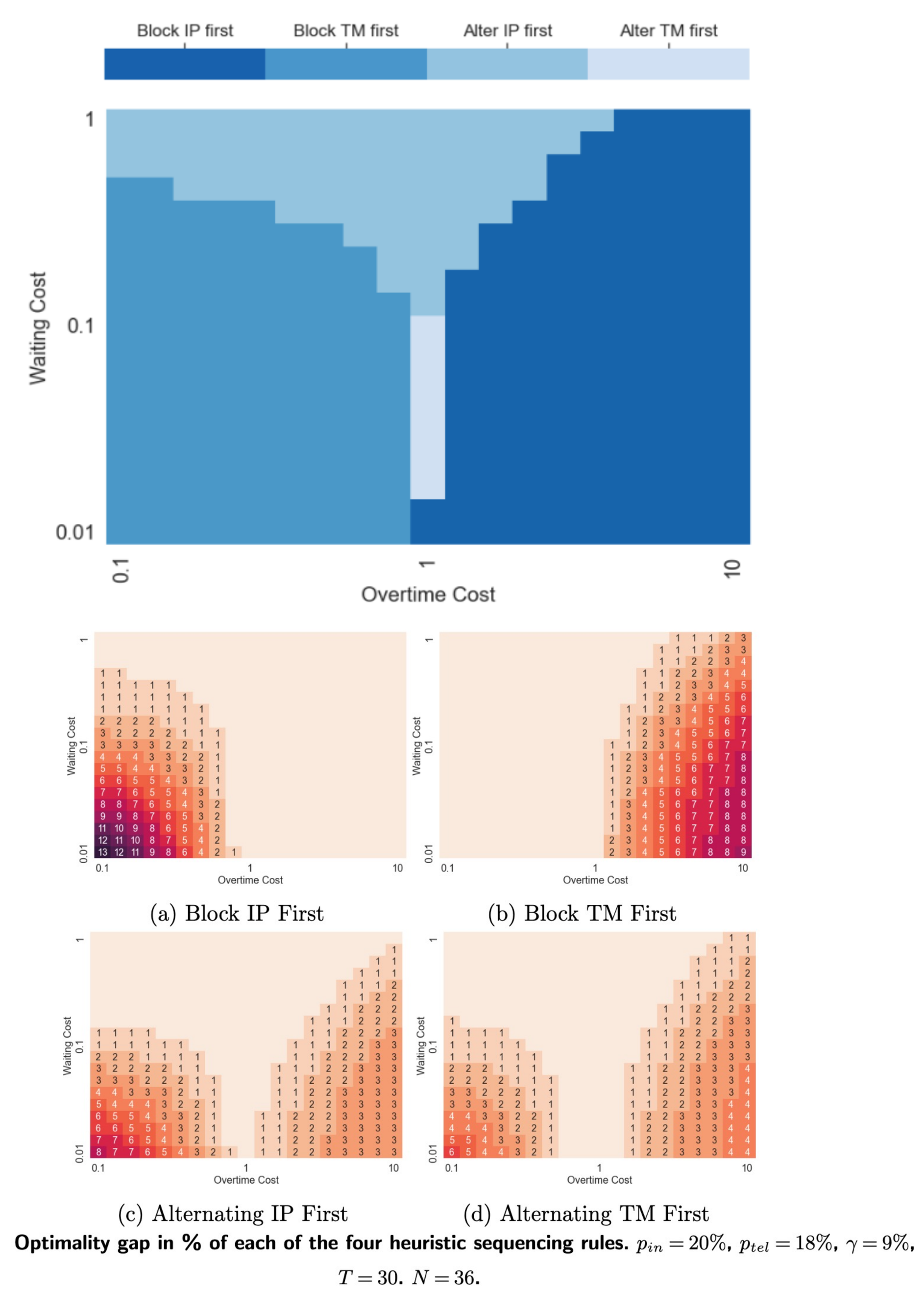


Figure 4. First panel: best-performing heuristic sequencing rules in our system dynamic. Second panel: the optimality gap when ignoring abandonment behavior.

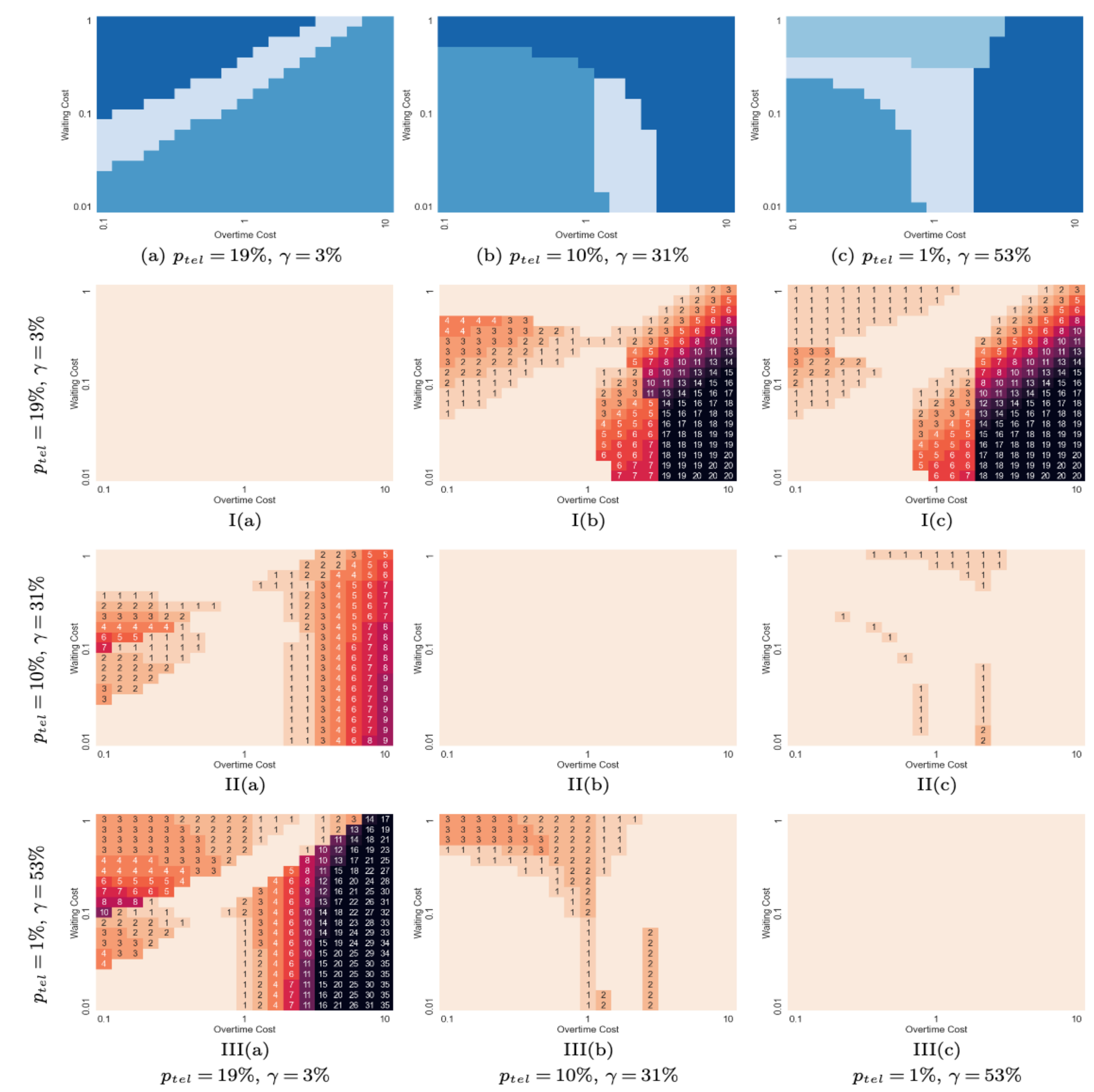


Figure 5. First panel: best-performing heuristic sequencing rules. Second panel: the optimality gap when applying the policies derived based on the wrong system dynamics

## Following Work

### Mechanisms: sunk cost and waiting information

### Lab experiment: willingness to wait for reward

- Qualification task (base payment $0.1)
  - Low sunk cost: 4 questions (~ 30 seconds)
  - High sunk cost: 30 questions (~ 3 minutes)
- Manipulated waiting period (6 minutes)
  - No waiting information
  - Delay announcement
- Main task (bonus payment $1.0)

| | Low Sunk Cost | High Sunk Cost | |
|---|---|---|---|
| Info: No | 0.575 | 0.420 | p = 0.002 |
| Info: Yes | 0.435 | 0.431 | p = 0.999 |
| p = 0.840 | p = 0.006 | p = 0.783 | p = 0.008 |

Table 1. Proportion of participants that abandon during the manipulated waiting period.

### Field experiment at CUIMC/NYP